Temporal and Spatial Variation in Growth and Age/Size Structure of the Fisheries for King Mackerel in the Gulf Of Mexico

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Abstract

We aged 4,038 king mackerel, *Scomberomorus cavalla,* from the eastern Gulf of Mexico and 2,652 fish from the western Gulf collected during 1986-1992 from Florida to Yucatan, Mexico, using sagittae. Length data were also collected on approximately 15,700 eastern and 19,800 western Gulf fish during 1986-1989. The overall age distributions for all age samples were quite similar between sexes within areas and within sexes between areas. The maximum ages and sizes of king mackerel from the eastern and western Gulf, respectively, were 22 and 23 yr and 127 and 117 cm for males and 21 and 24 yr and 158 and 147 cm for females. Growth was significantly different ($p < 0.01$) between sexes within regions and between regions within sexes. Mexican age samples were dominated by 1-3 yr olds compared to 1-8 yr olds in the U.S. western Gulf. Modal size of Mexican fish caught by commercial hook-and-line was 70-80 cm vs. 90 cm for west Gulf fish from Louisiana.

Introduction

King mackerel, *Scomberomorus cavalla,* are highly sought after by U.S. recreational and commercial fishermen from North Carolina to Texas (Manooch, 1979), and they support a substantial commercial fishery in Mexico as well (Gulf of Mexico and South Atlantic Fishery Management Councils, 1991).[3] The species is managed as two stocks or migratory groups, an Atlantic and a Gulf, although the Councils recognize that there are actually two groups-an east and a west-in the Gulf (Gulf of Mexico and South Atlantic Fishery Management Councils, 1990; Johnson et al., 1994).[4]

The life history and characteristics of the fisheries of king mackerel have been well studied (Beaumariage, 1973; Johnson et al., 1983; Trent et al., 1983; Manooch et al., 1987; Trent et al., 1987; Collins et al., 1989; Sturm et al., 1990). Except for the latter two studies, the usefulness of this information for current stock assessments is limited for several reasons.

Much of the work was based on data collected 15 to 25 years ago when exploitation rates and population size were certainly different; some studies were geographically limited; and all studies involving ageing relied solely on whole otoliths, which results in considerable under-ageing of older, larger fish (Collins et al., 1989).

One objective of this study was to compare the age and growth of king mackerel from the eastern and western Gulf of Mexico collected during 1986-1992. A second objective was to compare the age and growth of king mackerel from Mexican and U.S. waters in the western Gulf and to compare size distributions of commercial hook-and-line fisheries in those two areas.

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[3] Gulf of Mexico and South Atlantic Fishery Management Councils. 1991. Amendment 6 to the fishery management plan for coastal migratory pelagics in the Gulf of Mexico and South Atlantic. Gulf of Mexico Fishery Management Council, Tampa, FL and South Atlantic Fishery Management Council, Charleston, SC.

[4] Gulf of Mexico and South Atlantic Fishery Management Councils. 1990. Amendment 5 to the fishery management plan for coastal migratory pelagics in the Gulf of Mexico and South Atlantic. Gulf of Mexico Fishery Management Council, Tampa, FL and South Atlantic Fishery Management Council, Charleston, SC.

Methods

King mackerel were collected during 1986-1992 as part of a cooperative Mexican, state, and NMFS program designed to provide the age and length-frequency data needed to conduct stock assessments. For ageing data, we used stratified sampling to collect sagittal otoliths by year, region (E. and W. Gulf), sex, and 10-cm size interval, with a goal of 20 fish per stratum. The regions, which reflect current hypotheses on stock boundaries (Johnson et al., 1994; Gulf of Mexico and South Atlantic Fishery Management Councils, 1990[4]) were defined as 1) Eastern Gulf: Florida Keys through Mississippi, and, during April-October, Louisiana; and 2) Western Gulf: Mexico, Texas, and, during November-March, Louisiana. For most of the length frequency data, samplers attempted to collect, from fish selected randomly, fork lengths on at least 200 fish (and sex data whenever possible) each month from each type of gear during the fishing season. All fish were measured to the nearest centimeter fork length (FL) and all references to length herein are in those units.

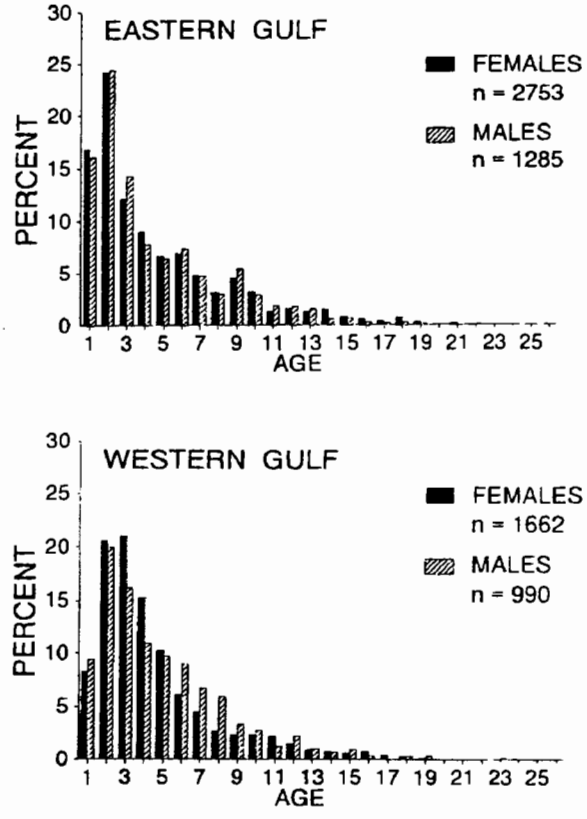

Figure 1. Overall age distributions by sex of king mackerel ageing samples collected during 1986-1992 from the eastern and western Gulf of Mexico.

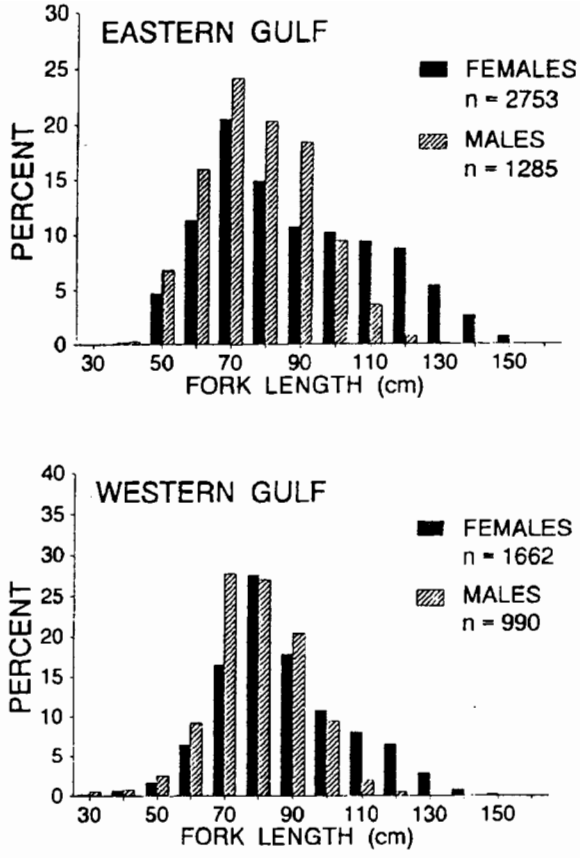

Figure 2. Overall size distributions by sex of king mackerel ageing samples collected during 1986 - 1992 from the eastern and western Gulf of Mexico.

Otoliths from males < 80 cm and females < 90 cm were read whole, while larger fish were aged using transverse sections of the otoliths.

Von Bertalanffy growth equations were fitted to quarterly observed lengths-at-age using Marquardt's nonlinear regression procedure (SAS Institute, Inc., 1988). We tested for differences in von Bertalanffy equations using an F statistic derived from the multivariate Hotelling's T^2 (Bernard, 1981; Vaughan and Helser, 1990).

Unsexed length frequency data were sexed using sex ratios generated from sexed length data collected in the same year, region, and 5-cm size interval. Age composition was estimated by ageing length frequency data using age data from the same year, region, sex, and 5-cm size interval.

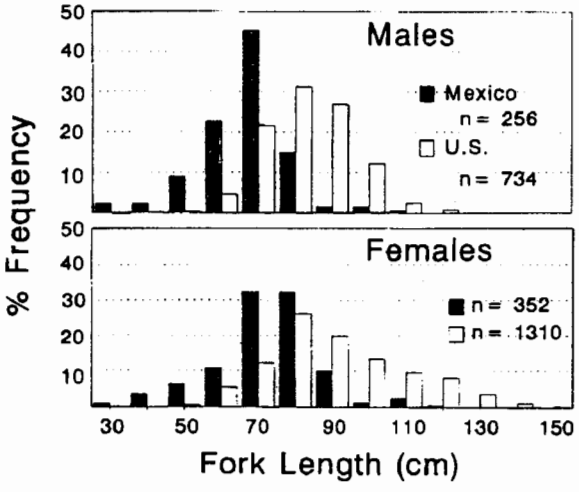

Figure 3. Overall size distributions of male and female king mackerel ageing samples collected during 1986 - 1992 in Mexican and U.S. waters of the western Gulf of Mexico.

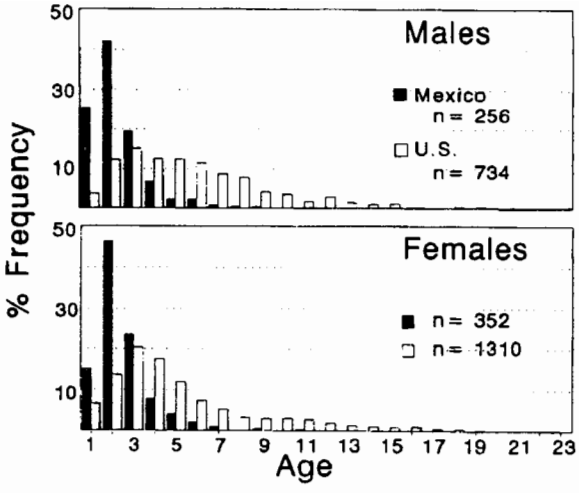

Figure 4. Overall age distributions of male and female king mackerel ageing samples collected during 1986 - 1992 in Mexican and U.S. waters of the western Gulf of Mexico.

Results and Discussion

The age distributions of male and female king mackerel in our ageing samples were very similar both within and between the east and west Gulf regions (Figure 1). The oldest males were 22 yr (110 cm) and 23 yr (101 cm) and the oldest females were 21 yr (127-150 cm) and 24 yr (144 cm) in the east and west Gulf, respectively. In both regions 99% of males were < 16 yr old, while 99% of females were < 18 yr in the east and < 17 yr in the west Gulf.

Maximum sizes were quite different between sexes, but within sexes, were similar between regions (Figure 2). Females grew much larger than males in both regions-158 cm versus 127 cm in the east Gulf and 147 vs 117 cm in the west Gulf. As one can see, the between-region differences within sexes are quite small. We realize that these are not random samples, and therefore do not represent the population distributions, but they do provide good estimates of typical maximum ages and sizes.

Within the west Gulf, males in the Mexican ageing samples were dominated by 70-cm fish with very few > 80 cm, while the mode of U.S. samples was 80 cm with many individuals to 100 cm (Figure 3). The size modes of females were not very different-70-80 cm in Mexican vs. 80 cm in U.S. waters, although the proportion of larger fish was much higher in the latter. The largest female and male from Mexico were 122 and 109 cm compared to 147 and 117 cm from the U.S.

The ageing samples from Mexico were dominated by 1-3 yr olds, with almost none > age 6, whereas 1-8 yr olds of both sexes were well represented in U.S. samples and fish to age 15 were fairly common (Figure 4). The oldest west Gulf males were ages 9 and 23 and the oldest females were ages 11 and 24 from Mexican and U.S. waters, respectively. These noticeable differences in age and size distributions of the ageing samples are most likely an artifact of sampling. All Mexican samples were from commercial fisheries, mainly gill nets and trolling, while many of the U.S. samples were collected from recreational fishermen.

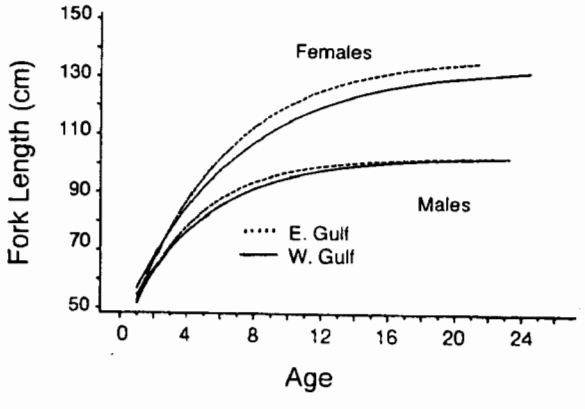

Figure 5. Von Bertalanffy growth curves for king mackerel from the eastern and western Gulf of Mexico collected during 1986 - 1992. Growth curves were calculated using individual quarterly observed sizes at age.

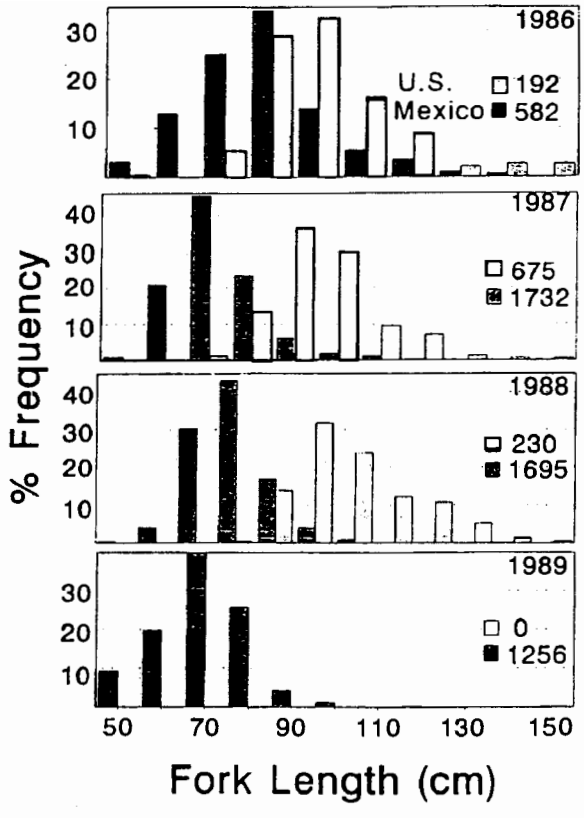

Figure 6. Annual size composition of king mackerel commercial hook and line fisheries in Mexican and U.S. waters of the western Gulf of Mexico, 1986 - 1989.

Estimates of L_∞ for E. and W. Gulf samples were 138.1 and 134.6 cm FL for females and 104.1 and 104.5 cm for males; Brody growth coefficients (k) were 0.172 and 0.149 for females and 0.253 and 0.192 for males in the same respective regions. Sample sizes for females and males were n = 2,753 and n = 1,285 in the east Gulf and n = 1,662 and n = 990 for the west Gulf.

Females grew significantly faster and larger than males ($p < 0.01$) in both regions and east Gulf fish had higher growth rates than west Gulf fish (Figure 5). Analyses indicated that most of the regional difference could be attributed to differences in the von Bertalanffy parameter t_0.

The annual size distributions of king mackerel caught by commercial hook-and-line from the Mexican and U.S. portions of the western Gulf during 1986-1989 were noticeably different (Figure 6). The mode of Mexican fish was 80 cm in 1986, then 70 cm the following three years, with very few > 80 cm. The mode of U.S. catches was 90 cm during 1986-1988, the three years for which we have data, with fish up to 120 cm fairly common. These U.S. fish were taken almost exclusively off Louisiana, an area known for large king mackerel. The 70-cm fish which dominated Mexican catches were rare in the U.S. samples.

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